This work was supported by U.S. National Institutes of Health grant *E*–4237 (U.S.).

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## Effects of 2-Chloroethyltrimethylammonium Chloride and 2,4-Dichlorobenzyltributyl Phosphonium Chloride on Growth and Transpiration of Slash Pine

The growth of many plants, including several tree species, can be retarded by CCC (2-chloroethyltrimethylammonium chloride) and 'Phosfon-D' (2,4-dichlorobenzyltributyl phosphonium chloride)[1–5]. In addition, CCC applied as a soil drench has led to increased flowering in some plants[6–8].

A small lath-house experiment, designed to test the effects of these compounds on 1-year-old potted slash pine (*Pinus elliottii* var. *elliottii*) seedlings, was installed at Olustee, Florida, in February 1962. Treatments consisted of: (1) CCC soil drench at rates of 0, 5, 10, 20 and 40 g/ft.$^3$ potting soil; (2) 'Phosfon-D' soil drench at rates of 0, 0·4, 0·8, 1·6, and 3·2 g of technical material per cubic foot; (3) CCC foliar spray at concentrations of 0, 2,000, 4,000, 8,000 and 16,000 p.p.m.; and (4) CCC foliar spray at the above concentrations plus 0·15 per cent wetting agent (Fasco 'Spreadhesit'). Soil drench applications were made in February, April, May, and July 1962. Foliar sprays were applied with a hand-operated 'flit gun' twice weekly, from February to September 1962. The experiment was set up in a randomized block design, replicated six times. Height measurements to the nearest 0·1 cm were taken at 2-week intervals throughout the growing season.

'Phosfon-D' concentrations were apparently too low to affect height growth of the seedlings, although it is possible that slash pine does not respond to this compound. Since 'Phosfon-D' is reported to be highly persistent in the soil, concentrations of 1·2, 2·4, 4·8 and 9·6 g per cubic foot should have existed in the soil by July. Cathey[2] has observed that approximately 25 times as much CCC as 'Phosfon-D' is required to retard the height growth of chrysanthemums. Nevertheless, complete lack of toxicity or other symptoms at the highest level of 'Phosfon-D' indicates that the dosages were too low.

CCC applied as a foliar spray, either with or without a wetting agent, significantly depressed seedling height growth. However, extensive damage to foliage (needles stunted and chlorotic) and developing shoots resulted at the two highest concentrations (8,000 and 16,000 p.p.m.), to the extent that this form of application is considered impractical.

The treatment showing most promise was the application of CCC as a soil drench (Table 1). Growth of trees receiving 40 g/CCC/ft.$^3$ soil became significantly less than check tree growth by the 10th week of treatment, levelling off at approximately 35 per cent of check tree growth from the 20th week on. Treatment effects were significant at the 0·005 level, with seedling height growth decreasing linearly with the logarithm of concentration. There was no apparent damage to the foliage.

Table 1. Effect of CCC Soil Drench on Total Seedling Height Growth

| Concentration (g/ft.$^3$ soil) | Average height growth (cm) | Percentage of check tree growth |
|---|---|---|
| 0 | 28·8 | 100·0 |
| 5 | 25·9 | 89·8 |
| 10 | 29·0 | 100·7 |
| 20 | 18·6 | 64·6 |
| 40 | 18·6 | 64·6 |

Table 2. Effects of CCC Soil Drench on Seedling Transpiration (72-h Weight Loss in g)

| Concentration (g/ft.$^3$ soil) | Average 72-h weight-loss (g) | Percentage of check tree loss |
|---|---|---|
| 0 | 409·2 | 100·0 |
| 5 | 235·8 | 57·6 |
| 10 | 177·5 | 43·4 |
| 20 | 90·8 | 22·2 |
| 40 | 85·8 | 21·0 |

It was noted early in the course of the experiment that soil in pots receiving CCC as a soil drench remained moist when other pots were relatively dry. On June 4, 1962, the potting soil was saturated with tapwater and allowed to drain overnight. On June 5, all pots were enclosed in polyethylene bags and weighed. Subsequent weighings were made on June 6, 7 and 8. Analysis of the data (total 72-h weight-loss) revealed a reduction, significant at the 0·005 level, in transpiration of seedlings receiving CCC either as a soil drench or foliar spray (Table 2). Response, as in the case of height growth, was linearly related to the logarithm of concentration.

As in the case of height growth, reduced transpiration of seedlings receiving CCC as a crown spray was difficult to assess because of foliar damage. The response to soil application is more clear-cut, since foliar damage is entirely absent. Height of the tree was considered as a possible contributing factor, but only a slight correlation ($r = -0{\cdot}055$) was found between total height of the check seedlings at the time of initial weighing and 72-h weight-loss.

After soil application of CCC at the two highest levels (20 and 40 g/ft.$^3$ soil), needles on treated trees were noticeably shorter than check tree needles. Fascicles from three different vertical positions on the current season's leader growth were clipped off and measured. Comparison of the needle-lengths of check trees with those from trees treated with the two high-level soil applications of CCC showed a significant difference ($t = 5{\cdot}132$, $P < 0{\cdot}001$). However, that needle length *per se* cannot account for the observed reduction in transpiration of treated seedlings is evidenced by the fact that the correlation between average needle length of check trees and 72-h weight-loss is not significant ($r = 0{\cdot}146$). One can only conclude that: (1) the observed reduction in transpiration is not due solely to reduced length of needle or size of tree; (2) the reduction is not due to blocking of water movement into the tree stem, since wilting does not occur. Possible factors are a reduction in stomatal opening due to the treatment, either directly or via reduced photosynthetic rate, reduced water utilization in the treated trees, and retarded root development.

I thank Dr. H. M. Cathey of the Agricultural Research Service, U.S. Department of Agriculture, Dr. R. E. Deems of American Cyanamid Company, and Dr. Staley L. Felton of Virginia-Carolina Chemical Corporation for their advice and assistance. Chemicals used in this experiment were kindly furnished by American Cyanamid Company (CCC) and Virginia-Carolina Chemical Corporation ('Phosfon-D').

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